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AN EXPERIMENTAL EVALUATION OF VISUAL ILLUSTRATIONS USED TO COMPLEMENT PROGRAMED INSTRUCTION.

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DESCRIPTORS- *PROGRAMED INSTRUCTION, *VISUAL STIMULI, *TIME FACTORS (LEARNING), CONVENTIONAL INSTRUCTION, *VERBAL STIMULI, ACHIEVEMENT, RETENTION, PICTORIAL STIMULI, TRANSFER OF TRAINING, COMPREHENSION, IDENTIFICATION TESTS, VOCABULARY, GRADE 9,

TO DETERMINE WHETHER ONE PROGRAMED VISUAL PRESENTATION MODE FACILITATES LEARNING BY CLARIFYING ASSUMED AMBIGUITIES IN VERBAL PRESENTATIONS AND WHETHER LEARNING TIME AFFECTS ACHIEVEMENT, FIVE CRITERIA WERE SPECIFIED--DRAWING, IDENTIFICATION (TRANSFER), TERMINOLOGY, COMPREHENSION, AND A COMPOSITE OF THESE. ALTHOUGH KNOWLEDGE PRE-TEST SCORES WERE USED AS COVARIATES, NO OTHER INDIVIDUAL DIFFERENCES OR CONTENT FACTORS WERE CONSIDERED FOR THE 141 GRADE 9 PARTICIPANTS, GROUPED FOR CONVENTIONAL (VERBAL ONLY) INSTRUCTION, PROGRAMED INSTRUCTION, AND PROGRAMED INSTRUCTION INCLUDING VISUAL PRESENTATION OF LINES, DRAWINGS, AND PHOTOS. IMMEDIATE POST-TESTS SHOWED LEARNING TIME WAS SIGNIFICANTLY LONGER FOR STUDENTS RECEIVING PROGRAMED INSTRUCTION, ESPECIALLY WITH LINE DRAWINGS. ALTHOUGH THE VERBAL AND PROGRAMED PRESENTATIONS WERE EQUALLY EFFECTIVE FOR SOME CRITERIA AND THE PHOTOS WERE MORE EFFECTIVE ON THREE CRITERIA, IT WAS CONCLUDED THAT VERBAL PRESENTATIONS ARE SUPERIOR FOR OVERALL EFFECTIVENESS, ECONOMY, AND SIMPLICITY OF PRODUCTION. DELAYED RETENTION TESTS FOR THE COMPOSITE AND COMPREHENSION TESTS SHOWED SIGNIFICANT SUPERIORITY OF THE LINE PRESENTATIONS. (LH)

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An Experimental Evaluation of Visual Illustrations Used to Complement Programed Instruction.

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Introduction

The use of many different types of visual illustrations in textbooks and laboratory manuals presupposes that they in some way aid or promote learning. Their inclusion is usually based not on instructional value but on their availability, attractiveness, cost, and the subjective feelings of the author as to what is best. Although prior research has established that visual aids used to complement instruction improves student achievement (Wise (24), McCowen (17), Bell et al. (4), Vernon (23), Murry (19), and Gropper et al. (13)), there is at the present time very little experimental evidence available indicating which types of visual illustrations are most effective in promoting student learning of specific types of educational objectives. It is not known how learners at different age levels will react to variations in the amount and kinds of stimulation contained within various types of visual illustrations. It may be that for specific types of students certain types of visual illustrations may impede rather than foster the learning process. Also, a specific type of visual may be most effective in facilitating student achievement on a performance test and have little or no influence in promoting achievement on a test designed to measure total comprehension of the material presented. It is possible that for some educational objectives the use of visual illustrations to complement verbal instruction is no more effective than the verbal instruction alone.

Status of Research on Visual Illustrations

Allen (1, p.121), in commenting on the "dearth of research on the effectiveness of pictorial illustrations", states "It appears that a great deal of study needs to be made of the factors within pictorial illustrations that lead to increased learning." Finn (12) and Dale (9) have recommended that for instructional purposes the more realistic or life-like the stimulus material is, the greater the probability it has for facilitating learning. Several theoretical orientations have developed out of this point of view: the sign similarity orientation developed by Carpenter (7), Dale's (8) cone of experience, and the iconicity theory identified by Morris (18). The proponents of the cited orientations contend that an increase in the number of cues or an increase in the realistic detail of the existing cues in the learning situation increases the probability that learning will be facilitated.

Recent research and related literature does not dispute the existence of a realism continuum; however, it does suggest the possibility that several visual continuums exist and certain ones may be more useful in predicting student learning of specific educational objectives (Travers, et al., (21); Travers, (22); Broadbent (5, 6); Livingstone (16); Jacobson (14, 15); Dwyer (11)).

Statement of Problem

The primary purpose of this study was to measure the effectiveness of various types of visual illustrations used to facilitate student learning of five specific educational objectives: knowledge of terminology, comprehension, knowledge of location, transfer of learning--the ability to identify the numbered parts of an illustrated diagram from information presented via the instructional presentation, and total understanding.

This study also attempted to determine the instructional effectiveness of a programed presentation as compared to a verbal presentation which was similar to the type of presentation made by many current textbooks. Comparisons were also made to determine the effectiveness of three types of visual illustrations used to complement programed instruction.

Specifically, the purpose of this study was to test the following null hypotheses:

(H_1) There are no differences in immediate retention on the five criterion tests (Drawing Test, Identification Test, Terminology Test, Comprehension Test and Total Criterion Test) among students receiving the verbal presentation, the programed presentation, and the programed presentations complemented by visual illustrations possessing different amounts of realistic detail.

$H_o: \mu_I = \mu_{II} = \mu_{III} = \mu_{IV} = \mu_V$*

(H_2) There are no differences in achievement on the delayed retention tests (Drawing Test, Identification Test, Terminology Test, Comprehension Test, and Total Criterion Test) among students receiving the verbal presentation, the programed presentation, and the programed presentations complemented by visual illustrations possessing differing amounts of realistic detail.

$H_o: \mu_I = \mu_{II} = \mu_{III} = \mu_{IV} = \mu_V$

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*μ represents the mean score for the population.

(H_3) There are no differences in time taken to progress through the respective instructional units among students receiving the verbal presentation, the programed presentation, and the programed presentations complemented by visual illustrations possessing differing amounts of realistic detail.

$$H_o: \mu_I = \mu_{II} = \mu_{III} = \mu_{IV} = \mu_V$$

Specific Objectives:

(a) To determine whether there is only one visual learning continuum complementing programed instruction which may be utilized in facilitating student learning of the five educational objectives measured or whether different visuals facilitate the learning of different educational objectives with varied degrees of effectiveness.

(b) To measure the amount of immediate and delayed retention among students receiving their respective instruction by means of the varied treatments: the verbal presentation, the programed presentation, and the three programed presentations complemented by visual illustrations possessing different amounts of realistic detail.

(c) To determine at what point in the visual continuum further increases of realistic detail in the visual illustrations fails to produce significant differences in achievement of the different educational objectives.

(d) To determine whether the amount of time that students studied their respective instructional presentation affects to a significant degree their achievement on the criterion tests.

Method

The experimental population for this study consisted of 141 ninth grade students. Because of absenteeism only 129 of these students were available for the delayed retention testing two weeks later.

Table 1. Assignment of Students into Treatment Groups for Immediate Retention Testing.

	Boys	Girls	Total
Verbal Presentation (Group I)	13	21	34
Programed Presentation (Group II)	10	15	25
Line Presentation (Group III)	13	15	28
Drawing Presentation (Group IV)	15	11	26
Photographic Presentation (Group V)	16	12	28

Table 2. Assignment of Students Present for the Delayed Retention Testing.

	Boys	Girls	Total
Verbal Presentation (Group I)	12	20	32
Programed Presentation (Group II)	9	14	23
Line Presentation (Group III)	12	15	27
Drawing Presentation (Group IV)	15	10	25
Photographic Presentation (Group V)	13	9	22

Treatment Groups

Verbal Presentation (Group I).

Students in Group I received their instruction via booklets containing 8½" by 11" sheets. Each booklet consisted of 1800 words and was presented in regular paragraph (textbook) form.

Programed Presentation (Group II).

Students in Group II received the same verbal information (1800 words) as did the students in Group I; however, their instruction was linearly programed into 37 paragraph-type frames on 8½" by 5½" sheets. Each frame contained a 2½" by 3¼" plate; the plates complementing the instruction of Group II contained one or two words emphasizing the main concepts being discussed verbally in the body of each programed frame.

To promote student interaction each programed booklet contained 89 fill-in questions; each frame contained from one to six questions which students were to answer mentally. Immediate feedback as to the accuracy of their response was provided by the correct response in the subsequent frame.

Line Presentation (Group III).

Students in Group III received the same programed instruction as the students in Group II; however, the plates complementing their verbal instruction contained line drawings depicting form and the relative locations of the parts of the heart as they were mentioned in the verbal instruction. Visual illustrations used to complement the instruction received by students in Groups III, IV and V were designed to present visually the same information that was being presented verbally.

Drawing Presentation (Group IV).

Students in Group IV received the same programed instruction as the students in Group II; however, the plates complementing their verbal instruction contained detailed, shaded drawings representing the parts of the heart as they were mentioned in the verbal instruction.

Photographic Presentation (Group V).

Students in Group V received the same programed instruction as the students in Group II; however, the plates complementing their verbal instruction contained realistic photographs depicting the parts of the heart as they were mentioned in the verbal instruction.

Criterion Tests

Each student received four individual criterion tests: Drawing Test, Identification Test, Terminology Test, and the Comprehension Test. Scores received on the four criterion tests were combined in a composite 78-item test designed to measure total understanding of the concepts presented.

Drawing Test

The drawing test (N=18 items) provided the student with a list of specific terms corresponding to the parts of the heart discussed in the programed presentations. The students were required to draw a representative diagram of the heart and place the numbers of the listed parts in their respective positions. For this test, the emphasis was on the positioning of the verbal symbols with respect to their concrete referents, not on the quality of the diagram they were to draw.

Identification Test

This multiple choice test (N=20 items) required students to identify the numbered parts on a detailed drawing of a heart. Each part of the heart which had been discussed in the programed presentation was numbered on the drawing. The students were provided with an answer sheet with corresponding numbers on which they could select the name of the part of the heart which corresponded to the number.

Terminology Test

This test (N=20 items) consisted of a series of fill-in questions; it was possible for one and only one specific answer to be correct. The test attempted to measure the learner's knowledge of referents for specific symbols and knowledge of the referent which would be most appropriately associated with the use of a specific symbol.

Comprehension Test

The Comprehension Test consisted of 20 multiple choice items Direct reference was made to specific parts of the heart as they would be while functioning. The student then was asked to identify the position that other specified parts of the heart would be occupying at that particular moment. This test required that the student have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes which occur during the systolic and diastolic phases. The Comprehension Test was designed to measure a type of understanding that occurs when the individual understands what is being communicated and can use the information being received to explain some other phenomena.

Total Criterion Test

Scores received on the four individual criterion tests were combined in a composite 78-item criterion test designed to measure total understanding of the concepts presented.

Physiology Pretest

A physiology pretest consisting of 36 multiple choice items was administered to all participants in an attempt to determine their prior factual knowledge of the functional aspects of human physiology. Scores on this test were used as the adjusting variable in the analysis of covariance technique to evaluate the relative effectiveness of the various treatment groups receiving programed instruction complemented by visual illustrations.

Procedure

The subject content selected for this investigation was the heart, the parts of the heart, and the functions of the heart. This content material was selected because it permitted the evaluation of several types of learning objectives as measured by the five criterion tests. The instruction booklets received by the different treatment groups were identical in terms of the verbal information presented. The verbal presentation was in paragraph (textbook) form. The other four treatment groups received instruction by means of programed booklets; information transmitted via the verbally programed channel was the same for each presentation; only the amount of realistic detail contained within the visual illustrations was varied.

This study attempted to determine: (1) whether programed instruction is more effective than conventional type textbook instruction in facilitating student learning of varied educational objectives, (2) which types of visual illustrations used to complement programed instruction are most effective in promoting optimum student learning of specific educational objectives, and (3) whether there was a significant difference in time taken to complete the various treatments in relation to achievement on the different criterion tests.

The technique of using visual illustrations to complement programed instruction in this research was decided upon because (1) students would be able to work through their instructional booklets at their own rate since the groups were permitted to study their respective visual illustration for as long as they felt necessary to understand the information being presented; (2) by permitting students to view visual illustrations complementing the verbal frames, it was hypothesized that they would be able to develop concrete referents and establish new relationships for the ambiguous content material being presented verbally; (3) the visual illustrations would provide a common background of experience for students in the respective treatment groups, i.e., many questions resulting from ambiguous interpretations of verbal statements may be answered visually; and (4) the visual illustrations would have a tendency to stimulate, maintain and focus student attention on the important aspects of the presentation.

Before the students received their respective presentations they were told the purpose of the study and that they would be tested immediately following the instruction period. Each student was allowed to take as much time as he needed to proceed through his instructional booklet; however, each was asked to write the time that he started working on his booklet, and also the time that he finished. As soon as each student finished working on his booklet, he was permitted to work on the criterion tests.

Results

On the analyses of the amount of time taken for the different treatment groups to complete work on their respective instructional booklets, a significant difference was found to exist. The F ratio for the analysis of variance was significant beyond the 0.01-level.

Treatment	N	S.D.	Mean
Verbal Presentation (Group I)	34	3.47	16.29
Programed Presentation (Group II)	25	4.10	26.16
Line Presentation (Group III)	28	5.22	30.32
Drawing Presentation (Group IV)	26	4.70	25.73
Photographic Presentation (Group V)	28	8.45	26.25

A. Students receiving the various instructional presentations completed their instruction in different amounts of time. The results were:

   1. It took significantly more time (0.01-level) for students in the programed groups (II, III, IV, V) to complete their instruction than it did for students in the verbal presentation group (I).

   2. It took significantly more time (0.05-level) for students receiving the line presentation to complete their instruction than it did for students in the three other programed treatment groups.

   3. No significant differences in time were found to exist between the programed presentation and the drawing presentation; between the programed presentation and the photographic presentation, or between the drawing presentation and the photographic presentation.

B. On the total criterion test the various programed sequences facilitated total student learning with differing degrees of effectiveness. In relation to the promotion of student achievement on the total criterion test (See Table 4):

Table 4. Total Criterion Test

Treatment	N	S.D.	Mean Physiology Test Score Initial	Total Test Mean Score Original	Mean Test Score Adjusted
Verbal Presentation (Group I)	34	5.73	15.61	25.53	24.95
Programed Presentation (Group II)	25	3.90	13.96	22.92	23.26
Line Presentation (Group III)	28	13.64	13.11	26.07	26.88
Drawing Presentation (Group IV)	26	5.28	14.81	22.65	22.53
Photographic Presentation (Group V)	28	7.06	15.14	29.61	29.30
GRAND MEAN			14.59	25.45	

1. The photographic presentation was significantly more effective (0.05-level) than the drawing presentation.

2. The verbal presentation was found to be as effective as each of the programed presentations.

C. In relation to the promotion of student achievement on the drawing test (See Table 5):

Table 5. Drawing Test

Treatment	N	S.D.	Mean Physiology Test Score Initial	Total Test Mean Score Original	Mean Test Score Adjusted
Verbal Presentation (Group I)	34	2.39	15.65	6.26	6.18
Programed Presentation (Group II)	25	2.02	13.96	5.80	5.85
Line Presentation (Group III)	28	4.84	13.11	7.29	7.41
Drawing Presentation (Group IV)	26	2.95	14.81	6.85	6.83
Photographic Presentation (Group V)	28	2.10	15.14	8.43	8.38
GRAND MEAN			14.59	6.92	

1. The photographic presentation was significantly more effective (0.05-level) than the programed presentation without visuals.

2. The verbal presentation sequence was found to be as effective as each of the programed presentations.

3. The drawing presentation was found to be as effective as the programed presentation, the line presentation, and the photographic presentation.

4. The line presentation was found to be as effective as both the programed presentation and the photographic presentation.

D. In relation to the promotion of student achievement on the identification test (See Table 6):

Table 6. Identification Test

Treatment	N	S.D.	Mean Physiology Test Score Initial	Total Test Mean Score Original	Mean Test Score Adjusted
Verbal Presentation (Group I)	34	2.29	15.65	6.71	6.55
Programed Presentation (Group II)	25	2.47	13.96	5.80	5.89
Line Presentation (Group III)	28	3.92	13.11	6.71	6.93
Drawing Presentation (Group IV)	26	2.14	14.81	6.46	6.42
Photographic Presentation (Group V)	28	2.74	15.15	8.57	8.49
GRAND MEAN			14.59	6.87	

1. The photographic presentation was significantly more effective (0.05-level) than the programed presentation.

2. The verbal presentation was found to be as effective as each of the programed presentations.

3. The drawing presentation was found to be as effective as the programed presentation, the line presentation, and the photographic presentation.

4. The line presentation was found to be as effective as both the programed presentation and the photographic presentation.

E. In relation to the promotion of student achievement on the terminology test (See Table 7), all instructional presentations were found to be equally effective.

Table 7. Terminology Test

Treatment	N	S.D.	Mean Physiology Test Score Initial	Total Test Mean Score Original	Mean Test Score Adjusted
Verbal Presentation (Group I)	34	2.68	15.65	6.27	6.07
Programed Presentation (Group II)	25	2.23	13.96	5.40	5.52
Line Presentation (Group III)	28	3.29	13.11	5.57	5.48
Drawing Presentation (Group IV)	26	3.30	14.81	4.73	4.69
Photographic Presentation (Group V)	28	2.89	15.14	5.89	5.79
GRAND MEAN			14.59	5.62	

F. In relation to the promotion of student achievement on the comprehension test (See Table 8), all instructional presentations were found to be equally effective.

Table 8. Comprehension Test

Treatment	N	S.D.	Mean Physiology Test Score Initial	Total Test Mean Score Original	Mean Test Score Adjusted
Verbal Presentation (Group I)	34	2.68	15.65	6.29	6.15
Programed Presentation (Group II)	25	2.23	13.96	6.28	6.37
Line Presentation (Group III)	28	3.29	13.11	6.54	6.74
Drawing Presentation (Group IV)	26	2.30	14.81	4.77	4.74
Photographic Presentation (Group V)	28	2.89	15.14	6.71	6.64
GRAND MEAN			14.59	6.14	

Delayed Retention Results

A. On the total criterion test (See Table 9) the various programed sequences facilitated total student learning with differing degrees of effectiveness in relation to the promotion of student achievement on the total criterion test:

Table 9. Total Criterion Test-Delayed Retention

Treatment	N	S.D.	Total Test Mean Score Immediate Retention	Total Test Mean Score Delayed Retention	Total Test Mean Score Delayed Retention Adjusted
Verbal Presentation (Group I)	32	6.21	25.38	26.50	25.83
Programed Presentation (Group II)	23	3.47	23.57	20.04	20.55
Line Presentation (Group III)	27	13.17	21.59	24.81	26.61
Drawing Presentation (Group IV)	25	7.18	23.37	19.89	20.52
Photographic Presentation (Group V)	22	7.62	28.60	25.25	22.47
GRAND MEAN			24.34	23.42	

1. The line presentation and the verbal presentation were significantly more effective (at the 0.01-level and 0.05 levels respectively) than the programed and drawing presentations.

2. The photographic presentation was found to be equally as effective as each of the other programed presentations.

3. The verbal presentation was found to be equally as effective as the line presentation.

B. In relation to the promotion of student achievement on the drawing test (See Table 10), all instructional presentations were found to be equally effective.

Table 10. Drawing Test-Delayed Retention

Treatment	N	S.D.	Total Test Mean Score Immediate Retention	Total Test Mean Score Delayed Retention	Total Test Mean Score Delayed Retention Adjusted
Verbal Presentation (Group I)	32	3.09	25.38	7.88	7.62
Programed Presentation (Group II)	23	1.61	23.57	5.96	6.15
Line Presentation (Group III)	27	5.15	21.59	7.19	7.86
Drawing Presentation (Group IV)	25	2.83	23.37	5.56	5.79
Photographic Presentation (Group V)	22	2.89	28.60	7.70	6.66
GRAND MEAN			24.31	6.88	

C. In relation to the promotion of student achievement on the identification test (See Table 11), all instructional presentations were found to be equally effective.

Table 11. Identification Test-Delayed Retention

Treatment	N	S.D.	Total Test Mean Score Immediate Retention	Total Test Mean Score Delayed Retention	Total Test Mean Score Delayed Retention Adjusted
Verbal Presentation (Group I)	32	2.60	25.38	6.53	6.34
Programed Presentation (Group II)	23	1.85	23.57	4.96	5.10
Line Presentation (Group III)	27	3.95	21.59	5.96	6.48
Drawing Presentation (Group IV)	25	2.72	23.37	5.07	5.26
Photographic Presentation (Group V)	22	2.90	28.60	6.03	5.50
GRAND MEAN			24.31	5.79	

D. In relation to the promotion of student achievement on the terminology test (See Table 12):

Table 12. Terminology Test-Delayed Retention

Treatment	N	S.D.	Total Test Mean Score Immediate Retention	Total Test Mean Score Delayed Retention	Total Test Mean Score Delayed Retention Adjusted
Verbal Presentation (Group I)	32	2.32	25.38	6.38	6.28
Programed Presentation (Group II)	23	1.07	23.57	4.83	4.90
Line Presentation (Group III)	27	2.24	21.59	5.33	5.59
Drawing Presentation (Group IV)	25	1.16	23.37	4.74	4.83
Photographic Presentation (Group V)	22	1.85	28.60	5.50	5.10
GRAND MEAN			24.34	5.40	

1. The line presentation was found to be significantly more effective (0.05-level) than both the programed presentation and the drawing presentation.

2. The photographic presentation was found to be equally as effective as each of the programed presentations.

3. The line presentation sequence was found to be equally as effective as the verbal presentation, the programed presentation and the drawing presentation.

4. The verbal presentation was found to be as effective as the line presentation.

E. In relation to the promotion of student achievement on the comprehension test (See Table 13):

Table 13. Comprehension Test-Delayed Retention

Treatment	N	S.D.	Total Test Mean Score Immediate Retention	Total Test Mean Score Delayed Retention	Total Test Mean Score Delayed Retention Adjusted
Verbal Presentation (Group I)	32	2.68	25.38	6.22	6.06
Programed Presentation (Group II)	23	1.64	23.57	4.30	4.42
Line Presentation (Group III)	27	2.94	21.59	5.67	6.09
Drawing Presentation (Group IV)	25	2.28	23.37	4.22	4.37
Photographic Presentation (Group V)	22	2.49	28.60	5.75	5.10
GRAND MEAN			24.34	5.27	

1. The verbal presentation and the line presentation were both significantly more effective than the drawing presentation.

2. The programed presentation without visuals was found to be equally as effective as each of the other programed presentations.

3. The photographic presentation was found to be as effective as the verbal presentation, the line presentation and the drawing presentation.

4. The line presentation was found to be as effective as the photographic presentation.

Conclusions

The Time Factor

The results of this study indicate that students who receive their instruction by means of programed booklets require significantly more time to complete their instruction than do those students who receive the same content material in typical textbook form. With respect to the programed treatments, it took students significantly longer to progress through programed units complemented by line drawings than it did the programed presentation without visuals and the photographic presentation. A reason for this may be that authors of instructional textbooks, workbooks and study guides have used visuals with simple line construction to teach and portray concepts for many years and students have developed the ability to learn from them. This type of visual illustration permits the deletion of much superfluous detail and directs the learners' attention to the message intended to be transmitted. The data obtained from this study seem to indicate that students who studied under the line presentation do spend considerable time in studying the accompanying illustrations.

Immediate Retention

In terms of instructional effectiveness, economy, and simplicity of production, the verbal presentation alone should be used to promote student achievement on both the immediate and delayed retention tests designed to measure (1) total student understanding of the concepts presented in the instruction; (2) knowledge of the specific locations of the various patterns, structures, and positions of the parts in the heart; (3) student transfer of learning, i.e., the ability to identify the numbered parts on a detailed drawing of the heart from information presented via the various treatments; (4) student learning of the referents of terms; and (5) the development of a new view, or reorganization of the material by the student. The effectiveness of the verbal presentation may be appreciated more fully if we recall that a major portion of the information that a student acquires is obtained in this manner. Out of necessity, students have developed the ability to select from verbally prepared scripts that information which is necessary and important.

The inability of the programed booklets with visuals to facilitate student achievement on the criterion tests as compared to the verbal presentation identifies a very serious problem. Although it is readily acknowledged that the effects of visual illustrations on learning depend predominately on the characteristics of the students,

the characteristics of the content, and the ways in which the content is organized, this does not preclude the fact that the use of visual illustrations to complement programed instruction did not increase student learning. The data indicated that the amount of time that the students spent studying the more complex illustrations (detailed drawings and realistic photographs) was minimal. Apparently students do not know how to learn from varied types of visual illustrations. It may be that their prior exposure to detailed drawings and realistic photographs has not been instructional in nature but designed primarily to acquaint them with reality. Another possible explanation may be advanced for the poor showing of the detailed drawing and realistic photographic sequences--the initial impact of excessive realistic detail may be sufficiently strong to detract attention from relevant and important learning cues, materials in the commentary and/or visual cues in the illustration. In other words, the learner may be so impressed and/or confused by the amount of realistic detail in a photograph that he may fail to identify the crucial learning cues in the learning situation.

In comparing the instructional effectiveness of the various programed sequences it was found that with presentations in which visual illustrations were more detailed student achievement did increase in three comparisons of the criterion tests. The same sequence, the realistic photographic sequence, was found to be most effective. On the total criterion test the realistic

photographic sequence was more effective than the detailed drawing presentation, on the drawing test the realistic photographic presentation was more effective than the programed presentation, and on the identification test the realistic photographic presentation was found to be more effective than the programed presentation.

It is possible that in this limited number of cases in which greater detail resulted in more achievement, the effectiveness of the photographic presentation may be explained by the fact that the more realistic detail provided more information which could be transmitted to the students who were reacting to them. Also, increases in realistic detail, relative to certain educational objectives, may tend to reduce the abstract nature of the visual representation and to minimize the variance in the students' interpretation of the information to be transmitted. Since the visuals are highly realistic and portray their message vividly, it follows that students would not have to spend excessive amounts of time in trying to locate the intended message. This assumption appears to be supported by the data obtained in this study. Students who received the realistic photographic presentation did not spend significantly greater amounts of time studying their respective illustrations than did students receiving the other programed treatments. In fact, in one case students spent significantly more time with the line presentation treatment than they did with the realistic photographic presentation.

Delayed Retention

In comparing the instructional effectiveness of the various programed sequences on the delayed retention tests, it was found that visual illustrations increased student achievement on the total criterion test and on the comprehension test. In each case the line presentation treatment was found to be more effective: (1) on the total criterion test the line presentation treatment was significantly more effective than the programed presentation without visuals and the realistic photographic presentation; (2) on the comprehension test the line presentation was found to be significantly more effective than the realistic photographic presentation.

The effectiveness of the line presentation treatment in facilitating student achievement on the delayed retention testing is in accordance with recent literature and research which indicates that line representations are most easily transmitted, received, recalled and reproduced (Jacobson, (14, 15); Attneave, (2); Barlow, (3); Travers, (22); Travers, et al., (21)). Travers, et al., (21, p. 5.25) have stated that visual data is stored in the nervous system in some form isomorphic with line drawings and this permits the individual to remember and reproduce such information with greater facility than more realistic information. This would seem to indicate that those visuals closely representing line drawings and containing the essence of the message to be transmitted would be more effective and

more efficient in facilitating learning than would realistic illustrations which would have to be coded initially by the central nervous system before being transmitted. Travers, et al., (23, p. 1.18) suggest that "inputs of information when received by the human organism are coded and most of the information available to the senses not only never enters the perceptual system but is not remembered by the system." Since excesses of realism may actually interfere with the transmission of information and bacause of man's inability to receive highly embellished stimuli, it becomes necessary for those educators who are concerned with the structure and use of visual illustrations to attempt to discover those stimuli characteristics that insure that the student will obtain the intended kinds of learnings.

Recommendations for Further Research

1. Further investigation similar to the present study is needed to determine the effectiveness of the various visual illustrations in achieving other educational objectives.
2. Since this is one of the first studies which has attempted to investigate the relative effectiveness of various types of visual illustrations in complementing verbal instruction, it should be replicated in the same and in other content areas in order to establish confidence in the results.
3. Similar investigation is needed along different dimensions, e.g., the effectiveness of color in photographs and drawings.
4. It should be determined how the implications for visual learning found in this study compare with the results obtained from other grade levels.

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